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DETAILED STRATIGRAPHY

# of the

EDMONTON DISTRICT

by

Donald Alfred Taylor.

A THESIS

Submitted to the University
of Alberta in partial fulfilment of the requirements for
the degree of Master of Science.

EDMONTON, Alberta. April, 1934.

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DETAILED STRATIGRAPHY OF THE EDMONTON DISTRICT

CHAPTER I

INTRODUCTION

GENERAL STATEMENT

The object of this thesis is to report on the detailed stratigraphy of the Edmonton district, and if possible, to correlate the beds of the Edmonton formation exposed in various outcrops in this area. The bibliography at the end of the report is a summary of the available literature on this, and in part, the surrounding area. The work included in the thesis involved both field and laboratory study, and also the perusal of the literature pertaining to this and neighboring districts.

ACKNOWLEDGMENTS

The writer wishes to acknowledge his indebtedness for criticisms and advice by Dr. P.S. Warren, and to Dr. J. A. Allan for his counsel and suggestions concerning the work. Thanks is also due to Dr. R. L. Rutherford for suggestions and discussions. During the first few days of field work the writer was assisted by Mr. H. H. Beach, who also compiled the cross-

section of the area from drill holes and observed outcrops.

LOCATION:

The area studied for this thesis closely follows North Saskatchewan river in a general south-westerly direction from Sec. 11, Twp. 54, R. 23, W4th M. to Big Island, Sec. 29, Twp. 51, R.25, W4th M. Outcrops were also found and recorded along Whitemud Creek from its confluence with Saskatchewan river to Sec. 1. Twp. 52, R.25, W.4th M.

The localities referred to are indicated on the topographical map of the area and are numbered consecatively, beginning at the north-east end of the area. The outcrops which are not sufficiently exposed for detailed study or possible correlation are marked with an "X".

The first outcrop noted on the river at the north-east of the area (No. 2), is estimated to be 180 ft. above the lower contact of the Edmonton formation, and the last outcrop, noted at the south-west end, (No. 44), is about 450 to 480 ft. from the base of the Edmonton.

PREVIOUS WORK

The first contribution toward the geology of the general area came from the early explorers

in Western Canada. Their attention was attracted to the burning coal seams and the outcrops of reddish burnt shale. Fidler,[X] (55.P.8), while on a journey across the plains in 1793, noted coal on the Red Deer River. He was the first to record the discovery of coal in the western plains.

David Thompson, (59), while in the employ of the North-West Trading Company in 1800, records the "Big Seam" which he described as "crude bitumen mixed with earth" oozing out of the bank about eight feet above the surface of the water.(55,P.9). He also noted lignite outcropping at intervals for a few miles above this point, and although he records the finding of coal fragments along the river, he apparently did not see coal at Edmonton.

In 1841, Sir George Simpson, (55,P.10), in his journey across the continent, was the first to mention the occurrence of coal in the river bank at Edmonton. In 1851, Sir John Richardson, (55,P.10), obtained samples of coal from Edmonton in association with clay beds and clay ironstone, which he considered to be Tertiary in age.

Dr. Hector,(34), as geologist on Captain

(X - These numbers refer to the bibliography at the end of report.)

Palliser's exploration party during the years 1857-60, was the first to give a more detailed account of the Edmonton formation and the coal beds found in it. At Edmonton he describes (34, P.72) the formation as being "composed of horizontal beds of arenaceous clays, sometimes passing into sandstone, generally in spherical concretions, and at others into clay shale." He considered the coal suitable for smelting iron ore (p.11), "..which also occurs in large quantities in the same strata".

Concerning the coal at Edmonton (p.72), he records two seams of 18 inches each under the fort, and on the opposite side of the river, a seam six feet thick with another four foot seam higher up. "In the middle of the six foot seam there is a very fine six inch parting of greenish magnesian pipe-clay, which works up into a lather, and is used by the women of the fort for washing blankets". This clay is undoubtedly bentonite. At that time the coal seams were not worked, but were used only in the blacksmith's forge. He also found baked clay and orange coloured ash from a burnt out coal seam at the first bend below the fort. In 1858, while examining the lignite along the river, he writes, (p.80), "The coal was still outcropping on the

river banks for five bends below Edmonton, associated with the shale and green sandstone as before". He apparently did not notice the "Big Seam" that Thompson recorded. Although he believed that coal beds extended 50 or 60 miles down-steam from Edmonton, yet the lowest point on the river where the lignite was actually observed was two miles below Edmonton.

Regarding the age of these strata, characterized by lignite and freshwater beds, Hector correlates them with horizon No. 1 of Meek and Hayden's section on the Missouri river. This section included Wealden (p. 230). At the same time he considered that the strata at Battle River, Edmonton, and the lower Red Deer river may be included in those of Upper Cretaceous or even Tertiary, and that further information was needed to determine their age.

A.R.C.Selwyn was the first member of the Geological Survey of Canada to give an account of the geology of this area. His report is included in the Annual Report of the Survey for 1873-4.

Selwyn introduced the name Edmonton for the formation in the vicinity of Edmonton, as he refers to the beds as "Edmonton coal rocks" (p.49),

"Edmonton coal-bearing beds", (p.50), and the "Edmonton coal series" (p.51). He classifies them as Lower Cretaceous (p.210), but believed that the formations downstream from Edmonton were above the lignite beds. (p.210-11).

At an outcrop one and one-half miles below Edmonton he records two thin coal seams. Regarding the altitude of the beds here, he states, (p.39), "The strata are generally nearly horizontal, though occasionally presenting a slight dip, three or four degrees to S. 29° E."

In 1875-6, R.W.Ells (26), sampled the Big Seam, but did not mention coal as occurring at Edmonton.

The foregoing reports relating to this area have been very general, and it was not until 1886 that more detailed work was attempted. This was accomplished and reported by J. B. Tyrrell in Vol. II of the Geological Survey of Canada. This work is outstanding in the geology of the north-west and can be considered a classic for the area.

Tyrrell estimated the thickness of the Edmonton formation to be about 700 ft. Regarding its dip, he finds that it varies greatly from place

to place. At Goose Encampment, 50 miles above Edmonton, they dip 16 ft. per mile, S.75° W.; eleven miles upstream, they dip 5 ft. 8 in. per mile. From Big Bend (Sec. 16, Twp. 52, R.25) upstream for 30 miles he considers the beds to be lying perfectly horizontal. At Big Island, Tyrrell notes an outcrop of coal three ft. 8 inches thick and 18 ft. above river level. From this point to Edmonton, a distance of 12 miles by river, he writes (p. 113), "The banks are everywhere concealed by slides, and often also by underbrush so that no sections could be seen".

He considers the Edmonton formation a brackish water series corresponding to the lower part of the Laramie, and to the lowest portion of the St. Mary River series of Dawson. (17, p. 114c). The formation underlies the Paskapoo beds and does not outcrop in the foothills, but lenses out towards the west (p.133). The presence of a widespread coal seam is taken to indicate the top of the Edmonton formation.

He considered that the source of the Edmonton beds and the gold along the river is the gneisses and granites of the Selkirk mountains, and that the lime in the formation was derived from the Devonian and Carboniferous rocks. The sediments were laid down in

a shallow sea bed by rapid streams carrying detrital material.

Tyrrell found only one boulder clay at Edmonton. He concluded that the underlying quartzite shingle was perhaps derived from the erosion of Miocene conglomerates.

In 1909, D.B.Dowling wrote a report , "The Edmonton Coal Field", Memoir 8, Geological Survey of Canada, which included a description of the mines then operating and a number of sections showing correlation of the coal seams of the area. Since then no detailed work has been attempted on the stratigraphy of this district.

CHAPTER II

GENERAL CHARACTER OF THE AREA

The area studied for this thesis is a part of the third prairie level of the Great Plains area. The relief is characterized by low and gently rolling hills. The general elevation of the third prairie steppe in this area ranges from 2,000 ft. at river level, to 2,250 ft. on the higher elevations.

The low relief of this district is due to the uniform rate of retreat of the Keewatin ice sheet, and the resulting uniform deposition of till over a wide area. In the surrounding area, the relief is sometimes greater than at Edmonton, due to modified recessional moraines. Such country is characterized by relatively poor drainage, swamps, and shallow lakes, sometimes without outlet.

There is a regional slope from west to east, from the foothills to the prairies.

The main topographic feature of the district is the valley of North Saskatchewan river, which has dissected the surrounding plain and cut its channel to a depth of some 150 to 175 feet. Downstream from Edmonton, the banks of the river become shallower and broaden out. The river mean-

ders in its valley, forming flood plains on the inside curve of the stream, while cut-banks are formed on the outside curves. The flood-plains are on an average of 25 to 35 feet above the present water level and are, in places, extensive enough to provide land suitable for cultivation. The width of the valley varies from one-half to nearly one mile, and the width of the stream itself is from 350 to 500 ft.

Of the tributaries to Saskatchewan river, Whitemud creek is the largest in the area and affords the only outcrops of the Edmonton formation away from the river itself. Although the creek is very small, and in the fall amost completely dry, yet it has a valley much larger than could have been produced by the present volume of water. An increased volume of the stream caused by greater rainfall in former times, may have been responsible for the formation of its large valley. The other tributaries to the river are short and usually intermittent. Their banks are covered in all cases with vegetation which completely conceals the underlying formations. Although outcrops of the Edmonton are frequent along Whitemud creek, there are usually only a few feet of rock exposed, the rest being covered with

vegetation or concealed by slumps.

The meandering of the river has produced steep cut-banks on the outside curve, and the banks so formed provide practically the only exposures of bedrock. On the inside curves, alluvial flood-plains are built up of sand and silt or hard tough clay. In such places, only a few feet of the underlying formation are exposed. The steeper banks which occur some distance back from the flood-plain support sufficient vegetation to hold the soil in place and completely cover the bedrock.

Away from the river, the Edmonton formation is completely covered by glacial drift and later lake deposits and now outcrops only at favored places along the banks of the principal streams. Unfortunately, not all cut-banks along the river provide outcrops which are significant for correlation. The Edmonton formation throughout the whole area contains a large proportion of clay and bentonite. The bentonite occurs disseminated throughout the shale and sandstone, as well as occurring in definite beds. When moistened, it not only becomes very greasy and slippery, but also expands greatly, thus causing extensive slumping and numerous slides which

completely hide the formation underneath. Such slumping conceals many cut-banks that would otherwise provide good geological sections. Plates II, III and X, illustrate some of the larger and more extensive slumps found along the river.

CHAPTER III

STRATIGRAPHY

THE EDMONTON FORMATION

DISTRIBUTION

In Alberta, the Edmonton formation, or its equivalent, occupies a broad synclinal trough which narrows down towards the south, until at the International boundary the width of the outcrop is only 18 miles. South of Little Bow river, north-east of Carmangay, the Edmonton formation merges into St. Mary River sandstone. The structure is known as the Alberta syncline, the trend of which is in a direction slightly west of north. In its northern extent, the maximum width of the Edmonton formation, measured in an east-west direction through Edmonton, is approximately 175 miles.

GENERAL CHARACTER AND RELATIONSHIPS.

The Edmonton formation is predominately light in color and consists of soft sandstones, shales, concretionary sandstone, clay ironstone bands, and coal seams. At Edmonton, near the bottom of the formation, workable coal seams occur. To the west, coal seams of commercial value occur near the top of the formation.

On Saskatchewan river, 50 miles above Edmonton, a 25-foot coal seam outcrops. It was first noted by Selwyn in 1873 and is now known as the Big Seam. The presence of the Big Seam has been used to mark the top of the Edmonton formation in this area. The Edmonton is here overlain by the Paskapoo formation, the lower part of which is characterized by 75 to 100 feet of massive cross-bedded sandstone. In the Drumheller area the Ardley seam marks the top of the Edmonton, and in Lesser Slave Lake district, the boundary is placed at two coal seams separated by eight feet of carbonaceous dark grey shale (4, P.11C).

The Bearpaw formation, which underlies the Edmonton, consists of dark-colored marine shales. On Bow and Red Deer rivers the upper Bearpaw shales grade into overlying marine and brackish water sands and shales. These beds are known as the Fox Hills formation and represent the shallow and brackish water deposits of the retreating Pierre sea. These transitional beds are overlaid by the brackish water Edmonton formation in southern Alberta.

Regarding the beds underlying the Edmonton formation in central Alberta, J. A. Allan states (3, P.10C): "Between Edmonton and the mouth of Stur-

geon river the river section exposes the lower beds in the Edmonton formation. The character of the beds in the Bearpaw formation cannot be determined on North Saskatchewan river on account of lack of exposures. However, there is sufficient distance along the river between the bottom of the Edmonton and the top of the Belly River formations to allow for the occurrence of the Bearpaw beds below the drift and alluvium in the valley". Thus the character of the underlying formation has not been definitely determined, and as a result, its nature and age, and relations to the Edmonton beds cannot be definitely stated.

West of this area, the fresh-water Paskapoo formation overlies the Edmonton. On Bow and Red Deer rivers, these fresh-water beds overlie the Edmonton formation unconformably.(61, P.54). In Red Deer valley, Allan and Sanderson (9) have reported a widespread disconformable contact between the Edmonton and Paskapoo formations.

R. L.Rutherford, in discussing the nature of the Edmonton-Paskapoo contact on North Saskatchewan river concludes (43, p.19):"....it is seen that the basal Paskapoo along the present eastern boundary

is characterized by the presence of massive, cross-bedded sandstones which average 75 to 100 feet in thickness. They are in no place found in contact with typical Edmonton beds, but on Pembina river they overlie shales and argillaceous beds which are more like the Paskapoo than the Edmonton. On Saskatchewan and McLeod rivers the beds immediately below these sandstones are concealed."

In western central Alberta, at the approximate western boundary of the Paskapoo, sedimentation was probably continuous from Edmonton time up into the Paskapoo formation and conditions of depositions were similar (43. p.21).

ATTITUDE AND THICKNESS

As already noted, the Edmonton formation occupies the central part of the Alberta geosyncline. In its eastern extent, it dips gently towards the west, but near the foothills, the formation has been involved in mountain-building movements and is tilted towards the east.

Tyrrell observed that the dip of the Edmonton formation varies greatly - from horizontal to 16 feet per mile (55,p.107). Selwyn, in 1873, notes (47, p.39): "The strata are generally

nearly horizontal, though occasionally presenting a slight dip, 3 or 4 degrees S 29° E." A dip of three or four degrees amounts to 276 and 369 feet per mile respectively, which is rather high for this area. The maximum dip observed by the writer was 24 feet per mile, or 16 minutes.

The dip of the beds in this district is towards the south-west. The dip is gentle and varies only slightly from place to place. From observed outcrops along the river, dips of from 10 feet to 24 feet per mile have been determined, and from elevations on the Clover Bar seam as determined by Dowling, the dip in a distance of over six miles was found to be 17 feet per mile.

STRUCTURE

No evidence of faults in the area was found, except in the case of slumping of surface layers along the river bank. Some of these slumps are quite large, and occur one above the other for some distance back from the water's edge.(See plates III, IV, and X.) Others are quite small but numerous, and completely conceal the underlying strata.

PALAEONTOLOGY AND CORRELATION

TABLE OF FORMATIONS (from L.S.Russell, 40, P. 124)

	ALBERTA				SASKATCHEWAN	
Time	Central Foothills Section	Central Plains Section	South-western Section	South-eastern Section	South-western Section	Time
Paleocene	Paskapoo	Paskapoo	Porcupine Hills Willow Creek	? Ravenscrag	? Ravenscrag	Paleocene
Lance	Saunders (Upper part)	break	? St. Mary River	break	break	Lance
Fox Hills		Edmonton		White-mud East-end	White-mud East-end	Fox Hills
Pierre		Bearpaw	Blood Reserve Bearpaw	Bear-paw	Bear-paw	Pierre

The Edmonton formation is essentially a shallow-water deposit laid down under varying conditions. It was preceded by the marine upper Pierre sea, and in some areas, by the transitional brackish-water Fox Hills formation. Fresh-water beds of the Tertiary Paskapoo formation succeed the Edmonton.

During the deposition of sediments in Edmonton time, the land was only a little below or a little above sea-level, with sedimentation taking place in shallow swamps, enclosed basins, or along shallow near-shore areas. The invertebrate fauna indicates fresh, brackish, and to a much lesser extent, marine life. The following fresh-water forms have been found in the Edmonton formation:

Unio danae (M. and H.)
U. consuetus (Whiteaves)
U. minimus n. sp. (Warren)
U. sandersoni n. sp. (Warren)
Sphaerium formosum (M. and H.)
S. planum (M. and H.)
S. heskethense n. sp. (Warren)
Viviparus cf. leai (M. and H.)
V. tasgina (Dyer)
V. retusus (M. and H.)
V. crickmayi (Dyer)
Campeloma tenue (Warren)
C. Multilineata (M. and H.)
C. nebrascense whitei (Russell ?)
Goniabasis tenuicarinata (M. and H.)
G.Webbi (Dyer)
G. whittakeri (Dyer)
Thaumastus linnaeformis (M. and H.)

T. linnaeformis tenuis n. var. (Warren)
Hydrobia recta (White)
Valvata filosa (Whiteaves)
Limnaea tenuicostata (M. and H.)
Physa copei (White)

From the upper part of the Edmonton on the Red Deer river in the vicinity of Drumheller, the following forms were obtained from a brackish-water horizon.(60, p.2.)

Annelid borings
Bryozoa undet
Nucula subplana (M & H.?)
Ostrea glabra (M.&H.)
Anomia micronema (Meek)
Anomia cf. perstrigosa (Whiteaves)
Mytilus albertensis n.sp.(Warren)
Modiolus dichotomus (Whiteaves)
Corbicula occidentalis (M. and H.)
C. cytheriformis (M. and H.)
Corbula subtrigonalis (M. and H.)
Panope (?) simulatrix (Whiteaves)
Lunatia obliquata (Hall and Meek)
L. occidentalis (M. and H.)

Commenting on these, Dr.Warren (60,p.4) states:"Such an assemblage of forms occurring in close association tends to show that the containing beds were deposited along a shore-line where brackish-water conditions prevailed, but with the water sufficiently clear and saline to admit of typical marine life". Close correlation is found difficult because of the long time range of the Montana species.

The age of the Edmonton as indicated by the vertebrates suggests a fauna intermediate be-

tween Belly River and Lance. L.S.Russell (40, p.151) concludes: "The Edmonton formation is principally, if not entirely, pre-Lance in age; the lower portion is correlated with the Pierre, the upper with the Fox Hills."

A list of the dinosaurs from the Edmonton formation is given by L.S.Russell in Proceedings for the American Philosophical Society, vol. 69, p. 150, 1930.

LITHOLOGY

All the sediments of the Edmonton formation in this district are fine-grained, a characteristic which is common to the Edmonton beds along the eastern limb of the Alberta geosyncline. To the west, the equivalent of the Edmonton is found in the Saunders sandstone. The beds are composed of carbonaceous, argillaceous and bentonitic shales, argillaceous, bentonitic and calcareous sandstones, clay-ironstone bands, bands of bentonite, and coal seams. The formation as a whole is quite soft and only occasionally are the beds sufficiently hard to form exposures in vertical cliffs. The shales are soft and often grade imperceptibely into hard or soft clays. The hardest shale layers are dark

in color and contain a large percentage of carbonaceous material. These dark shales are sometimes cleavable, but by far the greater proportion of the shales are soft and friable. Sometimes the shale is a rusty color due to the presence of limonite along the fractures. This is especially noticeable where the beds are near the surface. It is probably caused by surface-waters depositing their iron content.

Flattened tree trunks often appear as coal stringers in carbonaceous beds. Small cavities filled with resin are sometimes seen in association with them.

The sandstones are soft, and in only a few places are they sufficiently hard to form vertical cliffs. They are usually massive, but sometimes cross-bedding is seen, especially in the hard lenses and concretions. In hand specimens, the concretionary sandstone presents a "salt and pepper" appearance. It is made up of even-grained, angular fragments. The lighter material consists of quartz and some felspar. The darker specks are black chert. Limonite is present and appears as small brown spots throughout. The softer sandstones have the same general color and appearance, and sometimes

contain plant fragments and flakes of muscovite. The cement of the concretions is calcium carbonate. The sandstones are always light-colored and usually gray, but due to weathering, they are sometimes buff.

Calcium carbonate is the most abundant constituent in the clay-ironstone bands and nodules. Iron and clay and some other insolubles are also present. The nodules are sometimes fractured and the oppen fissures so produced are often filled with well-formed crystals of quartz or calcite or both.

The beds of the Edmonton which resist erosion to the greatest extent are clay ironstones. These are much harder and more compact than any other constituent of the formation. Due to their iron content, the nodules weather with a characteristic coating of limonite on the outside. The calcareous concretions and lenses in the sandstone, though hard, do not resist weathering, and are not found along the river bank.

Some of the beds comprising the formation are merely clays, which always contain a certain amount of bentonite. They are soft and very slippery when wet. The bentonite not only occurs in sandstone, shale and clay, but also in bands, varying

in thickness from a fraction of an inch up to two feet, and varying in color from white to yellow, greenish yellow, olive-green and brown.

Coal seams of commercial value occur in the Edmonton district. When fresh, the coal is hard and black, but on exposure to the air it loses moisture and becomes dull and crumbles. The Clover Bar seam in places reaches a thickness of nine feet, but in ~~all~~ others, all of this is not mineable as the upper part contains partings of bentonite, clay or black shale and poor coal.

The distinguishing features of the Edmonton formation in this area are as follows: the presence of bentonite in the sandstones and shales, and in distinct beds; the fineness and softness of the sediments making up the series, the variable nature of the sediments, both laterally and vertically; the typical bad-land weathering seen in a few suitably exposed outcrops; the numerous slumps and lack of vertical outcrops; the presence of clay ironstone bands and nodules; the thin-bedded nature of the sediments, and their typical light grey color; the rarity of fossils; and the occurrence of numerous coal seams.

CONDITIONS OF DEPOSITION

The conditions under which the Edmonton sediments were laid down varied greatly. The fauna indicates brackish and fresh-water conditions with, in one place, a slight admixture of marine forms as noted by Warren (60, p.4). Charles H. Sternberg, (53, p.38) gives the following vivid description of the conditions during Edmonton time in the Red Deer district: " A low country, but little above sea level, great flats near the sea covered with high swamp grass, rushes and moss, through which meander sluggish streams, lagoons, and bayous, often widening out into lakes of considerable size, all receiving the high and low tides of the nearby ocean. On the rising land the giant redwoods cast their shadows across the silent streams....Palms, sycamores, figs, magnolias and many other trees that now adorn our forests thrived along the Cretaceous everglades".

The cross-bedded but fine-grained sandstones show current action, probably under deltaic or estuarine conditions. The clays were carried into shallow water or enclosed basins, or were deposited along the flood-plains of rivers, or on mud

flats.

Carbonaceous shale, along with coal, was deposited in protected lagoons or in enclosed basins. At times, deposition must have been interrupted by the land being elevated above the water, for in one place along the river, mud cracks were found in shale. Shallow water conditions are indicated by wave-marked sandstone found at locality 25. Land conditions must have been present at one time, for leaves of two trees, an angiosperm and a gymnosperm, were found in a clay-ironstone nodule between locality 25 and 26.

UPPER CONTACT OF THE EDMONTON.

In this area, the later sediments overlie the Edmonton formation unconformably. The erosion surface, as observed from the outcrops along the river, was gently rolling. At locality 4 the top of the Edmonton formation is only about 5 feet above water level. In the Beverly mine, where the Clover Bar seam is worked at a depth of 148 feet, a washout was found. The coal seam ended abruptly against a gravel bed. The gravel deposit was made up entirely of chert and quartzite pebbles and sand. Although the deposits above could not be seen, it is probable that they

are post-Cretaceous in age, for twigs up to one - half inch in diameter were found in the gravel. They were not petrified, but quite soft, and the original structure of the wood was still preserved.

It is probable that the washout extends to the north of this mine at least as far as locality 4, for there are no indications of the Edmonton formation either along Second Rat Creek (locality 7), nor along the river bank. On the latter creek Dowling (21,p.28) notes that "...a shaft was sunk in expectation of finding a seam at 16 ft. There evidently had been an~~d~~ old channel here eroded which removed most of this coal in the vicinity of the shaft."

To illustrate the variations in elevation of the top of the Edmonton beds as exposed on the river bank, the following sections were chosen. The figures denote the distance of the top of the Edmonton above river level:

Locality	17	-	130	feet.
"	32		15	"
"	37		60	"
"	41		86	"
"	42		25	"
"	44		119	"

Where the erosion surface of the Edmonton is low, it has been noticed that springs along the

river bank are numerous. Where there is a rise in elevation, springs do not occur. Surface water is able to seep through the overlying sediments, but is stopped by the relatively impervious Edmonton beds which form a water table. Under these conditions, the lowest points in the Cretaceous sediments naturally collect the water from the higher.

Plates XI and XII (Sec.16, Twp. 52, Rge. 25, W.5th Mer.) show a line of springs flowing from the river bank at the top of the Edmonton beds. Here they are only 25 feet above the level of the river.

Springs may cause slumping by moistening the Edmonton bentonite-bearing beds, thus allowing the overlying sediments to slip downward more easily.

CHAPTER IV

STRATIGRAPHY (Continued)

DETAILED DESCRIPTION

The exposed strata in this area consist of upper Cretaceous beds of the Edmonton formation and of Pleistocene and recent deposits.

The centre of Sec. 1, Twp. 54, R. 23, W4th Mer. is the approximate centre of an ancient horseshoe shaped river channel, with its open end toward the north. Formerly the river flowed southward through the western opening of the valley and eroded a cut bank on the outside of the curve, whereas on the inside, terraces were being built up. Plate I shows the river valley and the terraces. An ox-bow lake now occupies part of the old river channel, the bottom of which is less than 25 feet above the present river.

No natural outcrops were observed along Pointe-aux-Pins creek which empties into the former river valley, nor were any found along the old valley itself, as vegetation completely covered the bank.

Commencing at the north-east end of the area, the outcrops found along the river bank

will be described consecutively in an upstream direction.

At location No. 1, a sand pit excavated in the bank of Pointe-aux-Pins creek exposes typical boulder clay showing prismatic form. It overlies pure, light-coloured coarse sand containing Precambrian pebbles. The sand forms a sharp contact with the till above, and is remarkably free from clay.

At location No. 2, (N.E. ¼, Sec. 27, Twp. 53, R. 23, W. 4th Mer.), a 20 inch coal seam with a two inch parting in the middle was observed 15 feet above water level, and its outcrop could be seen at intervals for 1,500 feet upstream along the cut-bank. The same seam occurs at water-level at location No. 3. In a distance of 1.5 miles, the coal seam drops 15 feet, giving a dip of 10 feet per mile.

One mile upstream from the last outcrop, but on the opposite side of the river, (location No. 4), there are only three to five feet of Edmonton beds exposed. Overlying these are four feet of gravel which contained no gneisses or schists that were definitely known to be in place. Near this same exposure, an outcrop showed the following

section:

(1) 10 ft. buff boulder clay.
(2) 15 ft. cross-bedded loose sand.
(3) 8 ft. sandy boulder clay, fine and coarse sand and gravel containing Precambrian pebbles. This boulder clay is less compact and darker in color than the till above.

(4) 51 ft. concealed.
(5) River level.

About four feet above water level are numerous iron-bearing springs, which probably mark the top of the Edmonton formation.

An outcrop of glacial drift extends from location No. 4 upstream for three-quarters of a mile. From location No. 6 downstream for almost a mile, the underlying formations are completely concealed by slumps. They form a series of parallel ridges between the river and the plains level. Boulder clay is exposed on the faces of these slumps in vertical outcrops, some of which occur as high as 75 feet above water level. Plate III shows one of these slumps.

At location No. 8, underlying an alluvial flood-plain is exposed a few feet of river deposits consisting of cross-bedded coarse gravel, sand, Precambrian boulders, coal fragments, clay ironstone nodules and pieces of Edmonton sandstone and

shale. These show little sorting thus indicating deposition by swiftly moving water. To the east of this location, gravel deposits were formerly worked about 75 feet above river level.

A landslide one-half mile above location No. 8 has exposed 20 feet of strata, in the uppermost part of which was found at least one foot of broken coal, indicating the presence of a coal seam slightly higher up.

An exposure in a gully 50 feet south of the eastern end of Clover Bar bridge (location No. 10), shows the following section:

(1) 20 ft. boulder clay. A large percentage of the boulders in this are Precambrian gneisses. The rest are quartzites and limestone.

(2) 8-12 in. quartzite gravel and sand. In this gravel, no Precambrian pebbles were found. The upper six inches consist of clean gravel, whereas underneath, the pebbles are mixed with grey shale and clay of the underlying formation.

(3) 4-5 ft. grey shale. This part of the section shows considerable disturbance, and is not stratified. It is grey in color, and in the upper part contains quartzite pebbles that have become mixed with the soft shale.

(4) 21 ft. grey sandstone, grading downward into rusty-colored sandstone.

All of the lower part of the section is

concealed. Across the river from this exposure, the Clover Bar seam outcrops 39 feet above water level. (location No. 11).

For about one mile along the right bank of the river south of the bridge, outcrops of a coal bed occur 75 feet above the Clover Bar seam. An exposure of the latter is seen on the road cut leading from river level at the bridge to the town of Clover Bar. Between localities 13 and 16, evidences of the seam are shown by old entries driven into the bank, and by ash and burnt shale outcrops. At the mouth of a small creek (locality No. 16), the Clover Bar seam outcrops about six feet above water level.

At locality No. 18, about 1,500 feet upstream from the Bush mine, the Clover Bar seam disappears under water. From locality No. 11 (elevation 2,040 ft.) to No. 18, (elevation 2,004 ft.) the Clover Bar seam drops 36 feet in a distance of 1.5 miles. This gives a dip of 24 feet per mile, the maximum which the writer has found in this area.

At the Bush mine, there is a well exposed outcrop of 150 feet of sediments where the mine water is discharged.

The following section was noted:

(1) 8 ft. boulder clay.

(2) 16 ft. quartzite gravel and cross-bedded sand.

(3) 3 ft. grey shale of the Edmonton formation.

(4) 4 in. to 2 ft. light yellowish-green bentonite.

(5) 20 in. brown and black carbonaceous shale.

(6) 10 ft. compact grey shale with a clay ironstone band.

(7) 8 in. clay ironstone.

(8) 4 ft. compact grey shale.

(9) 2 ft. hard black coal.

(10) 2 ft. 3 in. soft coal and dark brown shale.

(11) 7 ft. 6 in. sandstone.

(12) 10 in. hard black coal.

(13) 8 in. grey carbonaceous shale.

(14) 17 ft. grey compact shale.

(15) 1 ft. 8 in. hard black coal.

(16) 1 ft. black carbonaceous shale with some coal.

(17) 10 in. bentonite.

(18) 52 ft. dark to light grey shale with lenses and bands of clay ironstone.

(19) 14 in. hard black coal.

(20) 1 ft. brown carbonaceous shale with coal stringers.

(21) 6 ft. 6 in. brownish grey argillaceous shale.

(22) 16 ft. concealed.

(23) 32 in. black coal, lower part of which is concealed - the Clover Bar seam.

(24) Water level.

In a gravel pit at the mine, next to the waste dump, the following section is exposed: (See plate VIII)

(1) 9 - 15 ft. compact buff-colored till containing pebbles and boulders of gneiss, clay ironstone, coal, and soft grey sandstone.

(2) 7 ft. gravel underlying the boulder-clay and interstratified with cross-bedded even-grained sand containing coal fragments and fine gravel. The boulders and pebbles are all quartzites and chert, the largest of which measured six to seven inches in diameter. Although pebbles of gneiss and schist were carefully searched for, none were found. The upper 30 inches of the gravel are badly crushed. This bed shows a sharp undulating contact with the boulder clay above.

(3) Lower contact concealed.

200 feet upstream from the last mentioned outcrop, the following section is exposed:

(1) 15 ft. boulder clay.

(2) 10 ft. sand and gravel containing quartzite and chert pebbles. Most of the quartzites are smooth and precussion marked; others are crushed. The boulders are not facetted, but well-rounded as if by stream action. Coal fragments and silicified wood were

present in the gravel, but no Precambrian boulders were found.

(3) Lower contact concealed.

For some distance upstream from the Bush mine, the Clover Bar seam is well exposed at low water level. (location No. 18). The outcrop shows a 32 inch seam of poor coal, the lower part of which is concealed. A seam above this is at present burning along the bank, leaving ash and reddish burnt shale.

At location 20, three coal seams outcrop; the largest of these is 20 inches thick and occurs 20 feet above the river. At location 21, a small coal seam was found at water level.

The mine water from the Dawson mine (location No. 22) has exposed a section in which 22 inches of hard black coal was observed 40 feet above river level. Between here and location 23, extensive slumping has caused parts of the bank to slide into the river. Coal seams are in evidence from the ash and burnt shale, and from the pits and small drifts from which coal has been removed at low water. During the summer they are filled with water.

Location 24, measured on a road-cut east of the Low Level bridge, shows 48 feet of loose fine

water-lain cross-bedded sand directly overlying the Edmonton formation.

At location 25, about 1,400 feet upstream from the east end of Low Level bridge, a 68-foot section showing three coal seams is exposed. In its upper part, a bed of wave-marked sandstone was found. At the top occurs 15 feet of coarse gravel, which was probably laid down by the present river when at a higher level. Location 26 exposes the same three seams, but here they are each separated by a greater thickness of intervening beds. (See Columnar Sections 25 and 26). At water level a seam of good coal of unknown thickness outcrops. Pits in the bank indicate that this seam was worked at low water level, probably during the winter. At this locality two fossil leaves were found in a clay ironstone nodule.

Location 27, a section on a road-cut about 100 feet above the river, exposes 10 feet of typical boulder clay overlain by three feet of soft water-lain sand and underlain by 11 feet of soft sand. The latter rests directly on the Edmonton formation.

The river bank at location 28 shows out-

croppings of ash and red baked shale a few feet above water level. This may be the same exposure that Hector found at the first bend below the fort. (34, p. 72).

On a road cut by the Provincial power plant (location No. 29), three coal seams outcrop 33 feet above river level. These are probably the same that occur at localities 22 and 23. Higher up on the bank by the Provincial greenhouse, a gravel deposit showing cross-bedding is exposed. Besides gravel, the bed contains soft coal fragments up to four inches in diameter and masses of typical boulder clay up to 18 inches in diameter. The top of the gravel is 100 feet above river level where it forms a plain on which the old Parliament buildings are built. This elevation corresponds closely with that of 96 feet for the top of the gravel in section 25 and probably represents a terrace deposit contemporaneous with it.

The two foot coal seam found 27 feet above the river at location No. 30 is probably one of the three already noted at localities 25, 26 and 29. This may be the same seam that occurs five feet above water level in section 31.

At location 32, numerous iron-bearing springs appear 15 feet above the river. These probably mark the top of the Edmonton. The outcrop exposes 135 feet of boulder clay and water-lain sand which are overlain by 12 feet of lacustrine sand and clay.

Section 33, measured along an alluvial flood-plain, exposes 10 inches of hard black coal, 15 feet above the level of the river. The Edmonton is here overlain by nine feet of fine stratified alluvial silt. A layer of calcium carbonate found beneath a two-foot bed of hard concretionary sandstone contains one to one and a half inches of cone-in-cone.

Locality 34 shows a carbonaceous layer 12 feet above river level in a large slump. (Plate X) From here to the mouth of Whitemud creek, numerous slumps have concealed sections of the Edmonton, not only at water level, but also higher up on the banks.

Opposite the mouth of Whitemud creek (location 36), two entries driven into the bank show a one-foot seam of good black coal, which at high water is flooded. This is probably the same seam as that

found at section 33. Forty-seven feet above the river, a quartzite gravel bed about one foot thick directly overlies the Edmonton. It contains rusty-colored sand and coal fragments, but no Precambrian boulders. The gravel is overlain by 59 feet of water-lain sand and 59 feet of glacial deposits.

In Sections 39 and 40, the Edmonton formation outcrops in places below the alluvial flat. Section 34, which has been exposed by a small stream of water coming from a spring at the top, shows about 65 feet of soft bentonitic shales and sandstone.

At location 41(a), 21 feet of grey bentonitic sandstone outcrop above a large slump. The sandstone contains hard rounded calcareous concretions up to 18 inches in diameter. The sandstone in the slump contained several poorly preserved specimens of Unio.

At section 42 only 25 feet of the Edmonton formation is exposed. Its contact with the overlying gravel and sand is sharply marked by a definite horizon of iron-bearing springs which have not been able to penetrate the Cretaceous beds. (See Plates XI and XII). The gravel which overlies the Edmonton

formation here apparently does not contain Precambrian pebbles, but they are present in the overlying 90 feet of waterlain sand. The sand is overlain by till, upon which a deposit of fine stratified silt has been laid.

Between section 41(a) and 42 a number of fragmentary fossil bones were found. They were weathered from clay ironstone in which they had been preserved. Lithified tendons and teeth were picked up where they had been lying loose on the weathered surface of the sandstone.

L. S. Russell identified the following fossils from this locality:

- Mollusca
  - Gastropoda
    - Viviparus, cf. raynoldsanus Meek & Hayden.
- Vertebrata
  - Reptilia
    - Leurospondylus ? sp.
    - Deinodontidae, undet.
    - Saurolophus ? sp.
    - Hadrosauridae undet.

Although plesiosaurs are considered marine reptiles, Dr. Russell has shown (Can. Field-Naturalist, Vol. 45. pp. 135-137, 1931,)that one found in the Edmonton formation on Red Deer river probably lived in fresh or brackish water. Thus, from his conclusions regarding their habitat, the occurrence

of these bones in the Edmonton district does not necessarily indicate marine conditions.

From location 42 to Big Island no sections were obtained. Though the river has formed cut-banks, numerous small slumps conceal the underlying beds.

An outcrop at section 43 exposes a lens of hard grey sandstone seven and one-half feet thick and 25 feet long. It weathers to a buff color and merges laterally into rounded concretions, some of which are three feet in diameter. Ten feet below this occurs a nine inch band of poor coal and black carbonaceous shale. Eighteen inches of Big Island coal seam is exposed in section 44. The lower part of the coal is concealed. Numerous abandoned entries occur in this horizon, and burnt shale and coal fragments indicate the presence of the seam.

Whitemud creek is the only tributary stream to the Saskatchewan where sufficiently exposed outcrops were seen. On the right bank of the creek, not far from its mouth, numerous springs occur and have formed deposits of tufa, limonite and wad. The line of outlet of these springs is probably at the top of the Edmonton formation.

At section 50, over 75 small broken bone fragments were found in a slumped outcrop.

CORRELATION OF OUTCROPS.

The outcrops occurring at localities referred to in the text are plotted on columnar sections at the back of the report, and wherever possible, correlations from one outcrop to the next are shown. Regarding the discontinuity of coal seams in this are, Dowling concludes, (22, P.35), "These bore and mining records are very imperfect, but with the aid of a small diagram on which they have been plotted it is quite plain that all the seams above the Clover Bar are not continuous over any extent, even when such seams in No. 18 are found." In section "No. 18", four coal seams occur, two of which are seven feet thick, and two eight feet thick.

From an examination of the columnar sections, it is seen that some exposures do not show sufficient strata to be of value in correlating the beds. As coal and carbonaceous shale beds were found to be the more persistent, correlations were based on them. The first three outcrops plotted do not contain any beds that continue from one exposure to the next.

The coal at the top of location 11 is the Clover Bar seam, which appears in section 17 at water level. Twelve succeeding outcrops have been correlated by means of coal seams. Farther downstream, the outcrops are small, and due to the dip, beds contained in them do not outcrop again.

Some of the sandstones in well-exposed outcrops show cross-bedding, and if these were deposited under deltaic or estuarine conditions, would vary lithologically from place to place. Coal, however, was formed in enclosed basins or swamps with no current action. As a result, the nature of the beds is fairly uniform throughout the whole area of deposition.

The columnar section represents in a general way, the thickness and type of beds found in this area. The profile section, compiled by H. H. Beach, shows the correlation of coal seams throughout the district, based on observed outcrops, shafts and boreholes.

CHAPTER V

STRATIGRAPHY (Continued)

POST - CRETACEOUS DEPOSITS.

QUARTZITE GRAVELS.

At a number of places along the river, gravels have been found lying directly upon the erosion surface of the Edmonton formation. They contain chert and well-rounded quartzite pebbles which show precussion marks. No Precambrian pebbles were found in these beds. The thickest of the gravel deposits, 16 feet, was observed at the Bush mine (location 17). The upper 30 inches of the gravel, which is directly overlain by boulder clay, contains a considerable percentage of large and small crushed pebbles. Some are merely broken while others are crushed to a powder. Below this, the gravel is not crushed. The pebbles are all of hard material, except for small pieces of coal and shale which are local in origin. The gravel is interstratified with cross-bedded sand containing coal fragments and fine gravel. One flake of gold was found in a small sample panned from this sand.

Plate VIII shows the contact of the quartzite gravel with boulder clay.

At section 10, 8 to 12 inches of quartzite gravel directly overlies the Edmonton, and is overlain by 20 feet of boulder clay. Although the gravel bed was carefully searched, no Precambrian pebbles could be found. Its contact with the Edmonton is uneven, and pebbles in the lower part are mixed with clay and shale. The latter shows considerable disturbance for a depth of four or five feet.

The crushed gravel found in one locality and the disturbed shale directly overlain by quartzite gravel in another, would seem to indicate that at these two places at least the continental glacier moved directly upon the gravel and not upon the Edmonton beds.

At locations 4, 36 and 42, the quartzite gravel is directly overlain by waterlain sand, which contains clay, Precambrian pebbles, coal fragments, and pieces of clay ironstone.

As the boulder clay wherever observed here contains quartzite pebbles, the distribution of these must have been widespread rather than only occupying the present river valley. Dawson (19, p. 13) believes that the Saskatchewan gravel underlies the

glacial drift of the Great Plains and that it has been found some distance from Saskatchewan river while sinking wells. He mentions that McConnell found workable gold in some parts of the Saskatchewan gravel.

The Saskatchewan gravel was named and defined by McConnell in 1885 (31,P.70). He introduced the term South Saskatchewan gravel to include incoherent valley and lake deposits of gravels and silty beds, and belonging to an age intermediate "between the Miocene and the Quatenary and to belong mostly to the period immediately preceding the latter". He does not consider them all contemporaneous, as some exposures show Precambrian pebbles in the upper part of the quartzite conglomerate. "The deposit is usually confined to a single bed of conglomerate, varying in thickness from two up to 50 feet, composed of small quartzite pebbles precisely similar to those found in the Miocene, and either consolidated........or with its constituents lying loose in a sandy matrix. In some places the conglomerate is overlaid by a considerable thickness of sandy and silty beds. These gravels never rest on the Miocene........". In a footnote (p. 70), McConnell states that the same gravels are found on North Saskatchewan river and

elsewhere, and that they are in part derived from the Miocene.

There are several possible sources from which quartzite gravels in this district may have been derived.

The Tertiary conglomerates capping Cypress hills and Hand hills of southern Alberta, and the conglomerate beds found on Swan hills which may be correlated with those of the south, contain water-worn and percussion-marked quartzite boulders. The formation was more widespread than at present, and as a result of their being eroded by streams preceding the Keewatin glacier, were spread out over the plain. The quartzite gravels found in the Edmonton district are well rounded and percussion-marked. Thus the most probable explanation of their origin is that they were derived from the Tertiary conglomerates which once covered this, or nearby areas. They were deposited before the advance of the Keewatin glacier.

Regarding the Saskatchewan gravels of the southern plains, Williams and Dyer (61, p. 76) conclude, ".....that whatever the final means or age of deposition, most of the quartzite gravels of the southern plains belonged originally to the Cypress hills conglomerate formation of vast extent, the

clastics of which were derived by stream and river action from the Rocky mountains."

As it is considered that the Cordilleran glacier preceded the Keewatin ice sheet, the drift deposited by it would consist entirely of material from the mountains. Coleman believes (14, p.12) that the Cordilleran glacier reached as far east as 70 miles west of Edmonton. Due to the low gradient, outwash gravels from the glacier would not likely have reached as far east as Edmonton.

Although the Paskapoo beds are believed to have covered this area, it is unlikely that the boulders in their lower part were sufficiently abundant to have left the quartzite shingle now overlying the Edmonton.

It is not probable that the gravels directly overlying the Edmonton were deposited by the Saskatchewan river because they are widespread and vary in elevation from 20 feet to 110 feet below the general level of the present plain. Tyrrell, however, (55, P.114) apparently classes these gravels and the overlying sand as preglacial river deposits.

SANDS

In sections where the top of the Edmonton

surface is lower, it has been found that the depression is filled with from 15 to 90 feet of cross-bedded water-lain sand containing relatively few pebbles. At section 4, however, at an elevation of 51 feet above water level, an eight foot bed of sandy unstratified boulder clay is found to contain Precambrian pebbles. This deposit is darker than the usual buff-coloured boulder clay and is much more sandy. It is overlain by 15 feet of loose water-lain sand. At section 1, the sand directly underlying the boulder clay is clean and free from clay. It also contains Precambrian pebbles.

As the sand deposits contain Precambrian pebbles, they must have been derived, in part at least, from the north or northeast. Perhaps the only agent which could have transported the pebbles in such a widely distributed deposit was the Keewatin ice sheet moving south westward from the Precambrian area. The pebbles may have been reworked from a former boulder clay or other glacial deposit.

The sand deposits and possibly the sandy boulder clay (found at section 4) are the only evidence for two glaciations in this area.

Thus the sands represent an interglacial deposit between two advances of the ice sheet, the

first of which left no evidence other than the sand.

BOULDER CLAY

The Keewatin ice sheet deposited a boulder clay over the greater part of the plains area. In the Edmonton district the till has a massive, columnar or prismatic form and wherever exposures are found, they form perpendicular outcrops as are shown in plates III, IV, IX and XI. The till is typically buff in color and shows no signs of stratification.

The coarser material contained in the clay varies in size from sand grains up to boulders three feet in diameter. The boulders are gneisses, schists, quartzites, and limestone. The gneisses are smooth, well-rounded, and do not show scratches. The quartzites are rounded or flattened and only rarely show scratches. Limestone boulders are almost always highly polished, facetted and scratched.

In section 10, boulder clay directly overlies quartzite gravels. It is possible that the ice sheet, where it passed directly over the gravels, picked up all, or most of its quartzite boulders from them.

Only in one place was the till found to be directly upon the Edmonton formation. This occurrence is on the river bank about 50 feet downstream from the mine-water outlet of the Bush mine, (location No. 17). Here the Edmonton beds showed evidence of disturbance in their upper part. In all other outcrops examined, the boulder clay was lying upon quartzite gravel or sand.

As determined by Rutherford, (42), the general direction of movement of the ice was from S. 15° W. to S. 40° W. These determinations were calculated from the occurrence of two large masses of bituminous sandstone which had been transported by ice for 200 to 250 miles from the nearest known outcrop. As the sandstone underlies a relatively small area, it was possible to determine the direction in which the pieces had been transported.

The glacial deposits greatly influence the topography of the district. There is no evidence of terminal moraine deposits, the lack of which would indicate a uniform retreat of the ice sheet and the resulting uniform deposition of till. The lack of sorting in the boulder clay show the absence of water as the agent of deposition. The till was probably derived from subglacial, englacial and superglacial

material left behind as the ice melted or evaporated.

For the formation of an ice sheet, the necessary conditions are precipitation in solid form and a fairly low summer temperature. The temperature need only be a little below freezing. In order to allow the ice to flow on a low gradient over a large area, this was probably the case with the Keewatin ice sheet.

In discussing the properties of ice, Antevs (11a, p.69) notes that with the temperature of ice near its melting point, there is less resistance towards movement and so the slope of the land may be less. A thick sheet with its temperature near the melting point requires less slope than a thin sheet at the same temperature.

LAKE DEPOSITS

Deposits classed under this heading are found at sections 32 and 42 where they overlie the boulder clay. They are grey or light buff in color and show stratification. Silt deposits are probably more widespread than only these two sections would indicate, as outcrops which occur near the general plains level are rare.

Fine material carried into lakes ponded in front of the receding glacier filled up the depressions left by its retreat. These sediments by filling up many of the irregularities in the land surface, in part account for the low relief of widespread areas in the district.

RIVER DEPOSITS

River deposits are found on practically all the inside curves of the river, where they form the alluvial flood-plains. They are usually poorly exposed, as the current of the stream is not directed along the inside bank, and as a result, does not erode the plain deposits.

The few deposits that are exposed, show up to 20 ft. of Edmonton beds overlain by coarse river gravel containing gneiss, limestone and quartzite boulders and pebbles. The gravels are overlain by 10 to 15 feet of silt or tough massive clay. At location 31 the latter contains a marl deposit in which is found fresh-water shells. At one time a small lake must have existed within the river valley. A short distance upstream, the marl deposit grades into tufa containing limonite and wad.

Compact clays found on Saskatchewan river

near the mouth of Groat ravine resemble boulder-clay in that they are hard and tough and stand out in vertical bands. They show slight stratification with alternating buff and grey bands. Recent vertebrae and limb bones were found imbedded in the clay.

Regarding its origin, Ries and Keele (35,p.14) consider that "These clays were probably deposited in bodies of water lying in the wide basin-like depressions of the river valleys and impounded behind temporary dams formed by terminal moraines". These clays were at one time used for the manufacture of brick.

River gravels occurring 100 feet above water level were described on page 37 . Gravels occur along the banks near water level, and when the river is low, gravel bars are exposed. For the last three years they have been worked for gold by hand methods.

CHAPTER VI

ECONOMIC GEOLOGY

COAL.

The Edmonton beds are recognized as a coal-bearing formation, and commercial quantities are obtained from it in its upper and lower parts. In the Edmonton district, coal is mined from the lower 500 feet of the formation.

Although coal is of great economic importance to this area, it will be considered briefly here as Mr. H. H. Beach deals more fully with the subject in his thesis: "Geology of Coal Seams of Edmonton and District, and a History of Their Mining Development".

The coal is a good domestic fuel, but at present the market for it is only local. There are 38 mines operating four seams in the area, viz: the Clover Bar seam and two others above it and one below. The first mines were started by driving entries into the river bank at the outcrop of the seam. Many of the present mines use vertical shafts.

The production for the last five years is as follows:

1929 - 477,791 tons.

1930	-	454,293 tons.
1931	-	370,252 "
1932	-	417,310 "
1933	-	476,702 "

The maximum production was reached in 1913, with an output of 640,044 tons.

GOLD

According to Tyrrell, (58,p.72), placer gold was discovered in workable quantities on North Saskatchewan river in 1861 and is found from Rocky Mountain House to about 60 miles below Edmonton. Statistics on production between 1861 and 1887 are not recorded, but from 1887 to 1897 Dawson (19) records a total value of $223,000. Up to this time only hand methods had been used for recovery. After 1898 numerous dredges were constructed and the river thoroughly worked. Although the deposits were apparently enriched each year, the first workings proved to be the best. The gold is not being worked at present, except by some of the unemployed, who are reported to have recovered one dollar per day.

Regarding its origin, Selwyn in the Annual Report for 1873-4 (47, p.58) concludes that "...along with the disappearance in ascending the river of the boulders of granitic, gneissic and other

crystalline rocks, the auriferous character of the drift likewise dies out." He found no gold as high up as Rocky Mountain House, and the gravels there were all derived from the mountains. In the Annual Report for 1875-6, (49, P.82) Selwyn repeats his views that the original source of the gold is from the Precambrian rocks of the glacial drift.

Tyrrell, in the Annual Report for 1886, believed that gold was not found in paying quantities above Goose Encampment, 55 miles above Edmonton. At Sections 35 and 36, Twp. 50, Range 4, West of the 5th Meridian, he found a trace of gold in ashes from a burnt out coal seam and from clay-shale underlying it. On the basis of these analyses he concluded that the gold came from the Edmonton formation and had been concentrated by the river. He says that some of it may also have been derived from the glacial drift.

In the report for 1882 - 3 - 4, Dawson corroborates Selwyn on the origin of gold from the Precambrian rocks of the glacial deposits. In the Summary Report for 1898, Dawson states (19,p.13A) that gold is not found west of the western border of the eastern drift and that McConnell had found

gold in workable quantity in some parts of the Saskatchewan gravels. In the sinking of wells some distance back from Saskatchewan river, gold has been found in gravel. Dawson refers these to the Saskatchewan gravels.

Rutherford (43,p.35) considered that the gold in the river may be in a large part derived from the erosion of the Edmonton and Paskapoo formations. Tyrrell in 1915 (58) again states that the gold was deposited as a result of erosion of the Edmonton formation, and that it could not possibly have come from the glacial deposits. W.C. Howells, in studying the heavy residuals in the Paskapoo sandstone along North Saskatchewan river, found no gold in the formation.

BENTONITE

Some bentonite occurs in all the beds of the Edmonton formation, and in places is found in beds up to two feet in thickness. It often grades into clays with a brownish color. At present no use is being made of the bentonite, but it is interesting from the standpoint of its origin.

As defined by Ross and Shannon (Am.Ceramic Soc. Jour., Vol. 9, p.79, 1926) bentonite is

"a rock composed essentially of a crystalline claylike mineral formed by devitrification and the accompanying chemical alteration of glassy igneous material, usually a tuff or volcanic ash. It often contains crystal grains that were originally phenocrysts in the volcanic glass." In consideration of this, it is interesting to note that Sanderson (46) found a continuous volcanic ash bed in the Edmonton formation in the Red Deer district.

The bentonite beds are not persistent, and vary in thickness. At the Bush mine (locality 17) a bed of fairly pure cream-colored bentonite was found to vary from four inches up to two feet in a distance of about 50 feet. The thickness of bentonite bands also varies in coal mines.

Bentonite produces characteristic cracks and surface markings on the weathered surface of beds due to shrinkage on drying. When moistened, it increases greatly in volume and becomes very soft and slippery. It is likely due to this fact that such a large number of slumps occur in the outcrops along the river.

Although industrial applications of bentonite are many (50, 51), it has not been considered

profitable to work the deposits in this area.

CLAY AND SHALE

At one time surface clays and flood-plain deposits were worked by a number of companies for the manufacture of brick, but at present none are operating. The shales have never been used on a commercial scale. Ries and Keele (35,36,37) deal fully with the shale and clay deposits in memoirs 24, 25 and 47 of the Geological Survey of Canada.

GRAVEL

Gravel deposits occur in the bottom of the river valley and higher up on the banks. River gravels are scraped up in piles at low water level and provide suitable material for cement making. The gravels approximately 100 feet up the bank contain too much clay and coal to be used for cement ? Concrete making. They are used for surfacing roads.

CHAPTER VII

SUMMARY AND CONCLUSIONS.

The exposed strata in this area consist of upper Cretaceous beds of the Edmonton formation and of Pleistocene and recent deposits.

The Edmonton formation varies greatly both laterally and vertically. It is predominately light in color and consists of soft sandstones and shales, clay-ironstone bands and nodules, and coal. The formation was laid down under greatly varying conditions. The cross-bedded sandstone layers indicate rapid water action, whereas the thin bedded shales indicate deposition along flood-plains or mud flats, and the coal and carbonaceous shale show deposition in enclosed basins or swamps. The fauna indicates that the Edmonton beds were deposited in fresh or brackish water.

The estimated thickness for the beds in this area is from 350 to 380 feet. The formation dips 10 to 24 feet per mile to the southwest, with an average of 16 or 17 feet per mile.

The Edmonton sediments are post-Bearpaw and pre-Lance in age. The lower half corresponds in age to the Pierre and the upper half to Fox Hills.

The Quartzite shingle is considered to be the Saskatchewan gravels as defined by McConnell and the overlying sand as an interglacial deposit between two advances of the ice sheet.

Due to the variable nature of the beds, lack of a widespread horizon marker, and insufficiently exposed outcrops, it has been found that correlation of strata in the district cannot be accomplished by this means alone. With more numerous and accurate bore-hole and shaft records it may be possible to correlate beds over a wider area.

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PLATE I

Looking southwest across a former river channel containing an ox-bow lake. (Sec. 1, Tp. 54, R. 23, W. 4th Mer.). Terraces are shown on the inside curve of the river. Slump ridges appear in the foreground.

PLATE II

General view of North Saskatchewan river valley looking upstream from Clover Bar bridge. Flood plain in foreground, high banks shown in the background, and to the right.

PLATE III

A long slump showing vertical faces of boulder clay. (Sec. 30, Tp. 53, R. 23, W. 4th Mer.)

PLATE IV

A series of slumps, exposing vertical faces of boulder clay at Big Bend. These slumps may be seen in Plate XI.

PLATE V.

Looking northward through a former river channel just west of Clover Bar bridge, taken from the railway embankment. High banks of the Saskatchewan are shown in the background.

PLATE VI

Looking southward through same river channel as in Plate V. High banks of the Saskatchewan are shown in the background. Note numerous pits in the valley caused by subsidence due to mining operations.

PLATE VII

View of Black Diamond mine from opposite side of the river. The entry in the river bank marks the elevation of the Clover Bar Seam.

PLATE VIII

View of gravel pit at the Bush Mine showing 8 feet of boulder clay underlain by cross-bedded sand and quartzite gravel. The head of the hammer marks the contact. Tipple of the mine in the left background.

P L A T E IX

Outcrop of boulder clay 50ft. south of east end of Clover Bar bridge. Note the vertical outcrop, boulders, and columnar form of the boulder clay.

P L A T E X

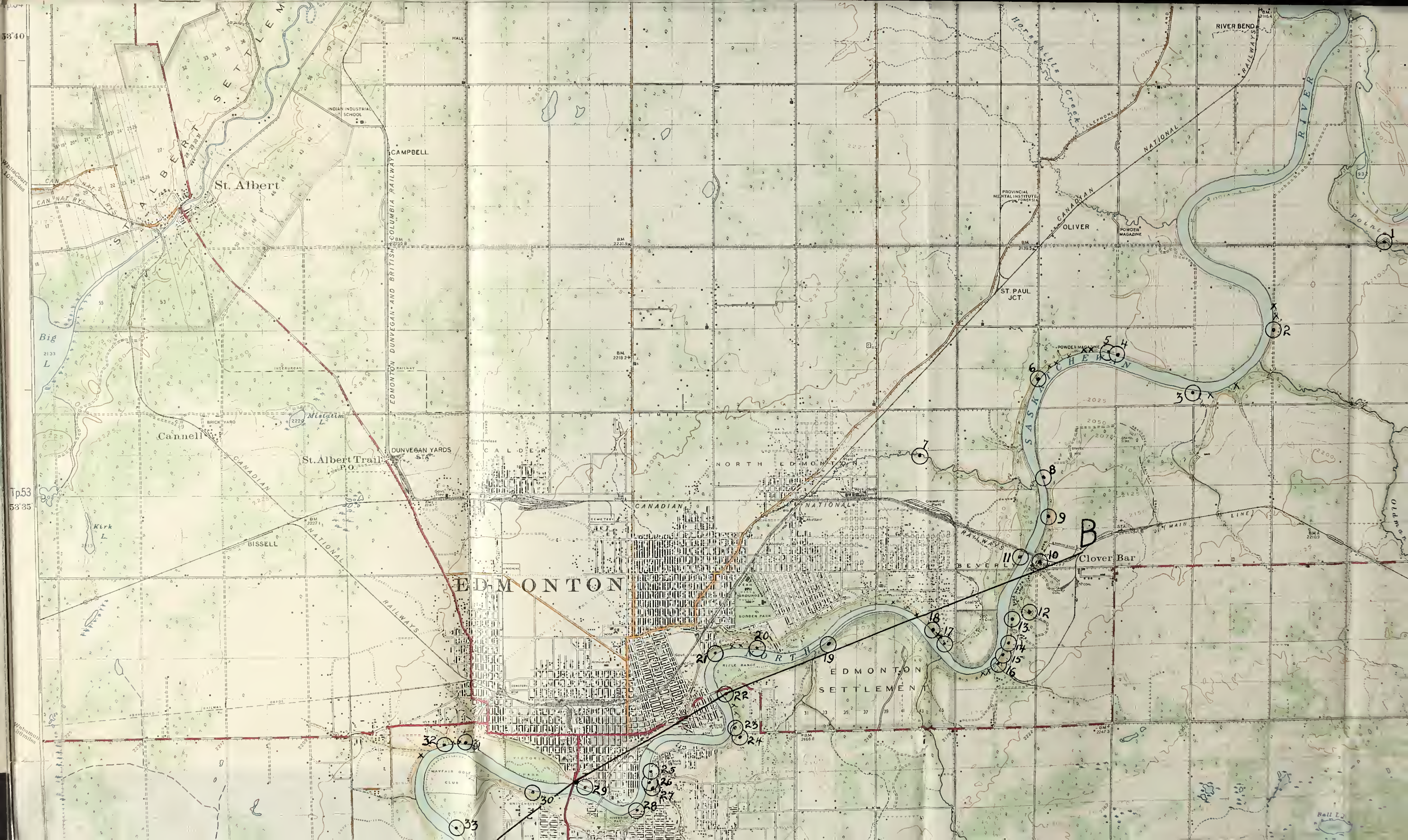
Slumped outcrop of Edmonton beds. Light beds are bentonitic; the dark beds are carbonaceous. (Locality 34.)

PLATE XI

View of river bank at Big Bend, looking downstream. Shows springs issuing from the bank and vertical outcrops of boulder clay. (Sec. 15 and 16, Tp. 52, R. 25, W. 4th Mer.)

PLATE XII

View of river bank at Big Bend, looking downstream. Shows springs flowing from the bank at top of the Edmonton formation, 25 feet above river level. (Sec. 15 and 16, Tp. 52, R. 25, W.4th Mer.)


53°40
Whitecourt 105 miles
St. Albert
ST. ALBERT SETTLEMENT
CAN. NAT. RYS.
INDIAN INDUSTRIAL SCHOOL
HALL
CAMPBELL
EDMONTON DUNVEGAN AND BRITISH COLUMBIA RAILWAY
Big L
Kirk L
Mistatim L
Cannell
BRICK YARD
St. Albert Trail P.O.
DUNVEGAN YARDS STA.
CALDER
CITY LIMIT
NORTH EDMONTON
CANADIAN NATIONAL RAILWAYS
BISSELL
Tp53
53°35
EDMONTON
BORDEN PARK
RIFLE RANGE
EDMONTON SETTLEMENT
BEVERLY
Clover Bar
B
MAIN LINE
Horsehills Creek
TELEPHONE
PROVINCIAL MENTAL INSTITUTE
OLIVER
POWDER MAGAZINE
ST. PAUL JCT.
RIVER BEND
SASKATCHEWAN
RIVER
NORTH
Pointe
Oldman
Wabamun 38 miles
VICTORIA PARK
MAYFAIR GOLF CLUB
UNIVERSITY
RIVERSIDE
Ball L
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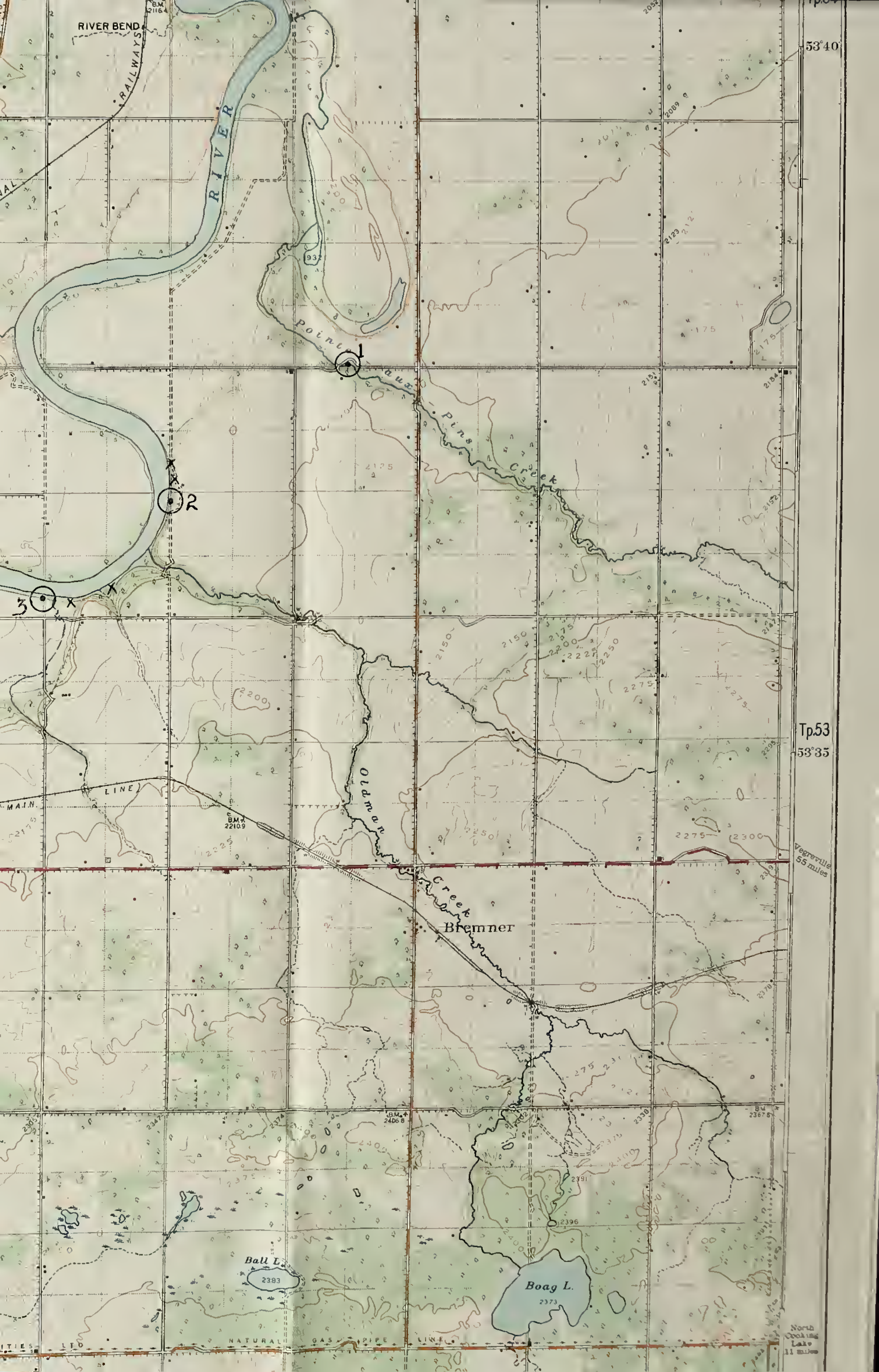
RIVER BEND
B.M. 2116.4
RAILWAYS
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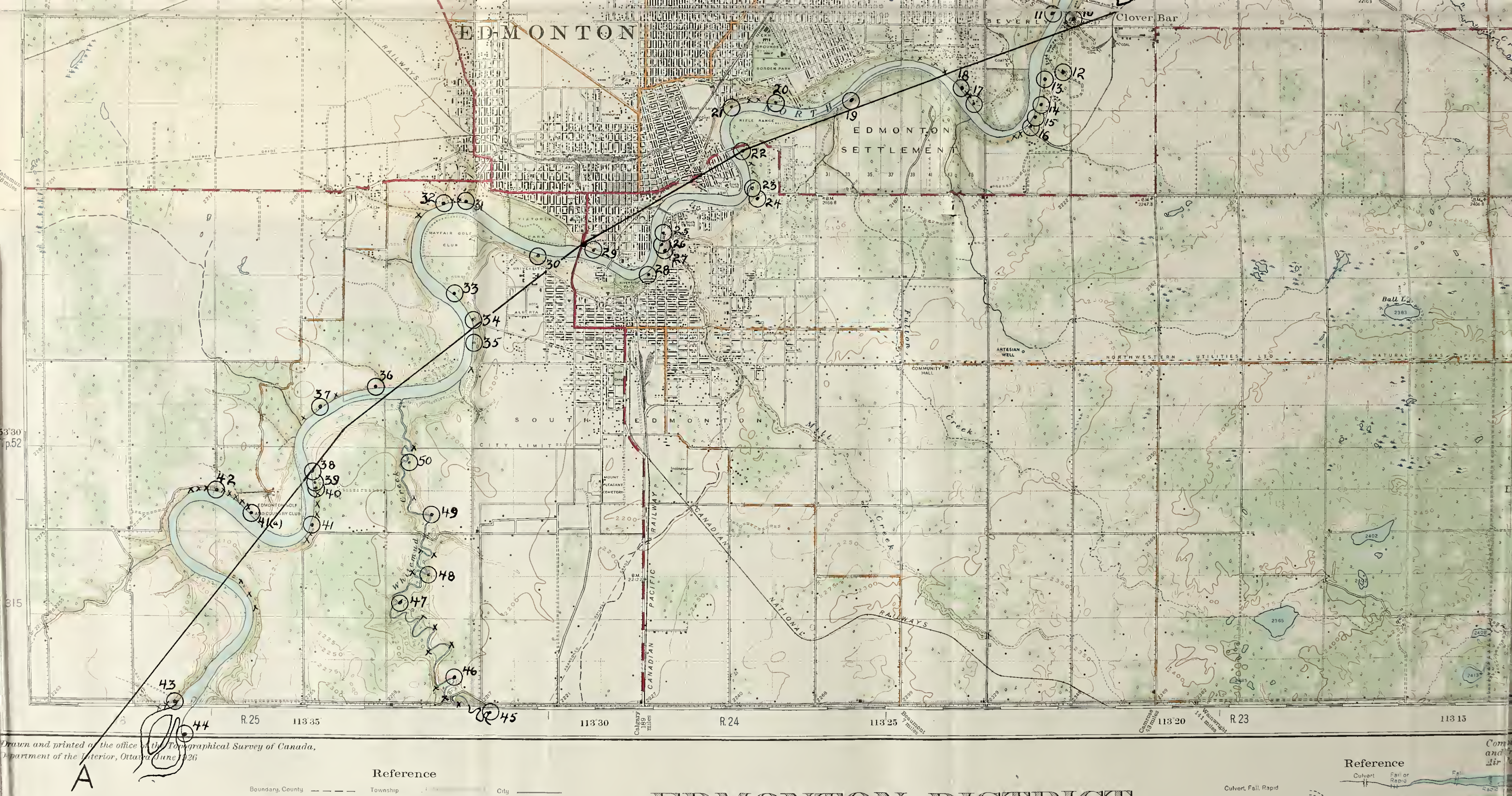
RIVER
Tp.53
53°40'
2089
2123
2175
Pointe aux Pins Creek
1
2
3
2175
2151
2134
2152
2150
2175
2200
2225
2250
2275
2200
Oldman Creek
MAIN LINE
B.M. 2210.9
2225
2175
Tp.53
53°35'
2300
Vegreville 55 miles
Bremner
2370
2275
B.M. 2406.8
B.M. 2367.5
2398
2374
2347
2365
2400
2375
2391
2396
Ball L.
2383
Boag L.
2373
NATURAL GAS PIPE LINE
TIES LTD
North Cooking Lake 11 miles



Drawn and printed at the office of the Topographical Survey of Canada,
Department of the Interior, Ottawa, June 1926

MAGNETIC DECLINATIONS
JULY, 1926

Fort Saskatchewan............25° 49′ E. of N.
Edmonton......................26° 46′ E. of N.
Cardiff.........................26° 47′ E. of N.

Declinations are decreasing 6′ annually.

NOTE: The location of the grid lines is shown by small ticks in the margin of the map. The numbers of the grid squares which are four miles to a side increase to the north and to the east, those for the square at the southwest corner of the sheet are given.

Reference

Boundary, County
Township
City
Railway, Double track
" Single track
" Electric
Station
Siding or stop
Above grade
Grade
Below grade
Cutting
Embankment
Tunnel
Road, class 1, trunk road
" " 2, secondary thoroughfare
" " 3, local road well travelled
" " 4, " " slightly travelled
Surfaced
Unsurfaced
Pack Trail or Path.
Telephone or Telegraph
Electric power line
Along road
Pipe line
Canal and Locks
Aqueduct
Ditch and Irrigation canal
Waterpipe
Muskeg
Marsh
Non-permanent lake
Alkaline flat
Bridge, Masonry
" Iron or wood
" Swing bridge, iron or wood
Dam, Wood or masonry

EDMONTON DISTRICT

Scale 1:63,360, or 1 inch to 1 mile

Miles 1 0 1 2 3 4 5 Miles
Yards 2000 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 Yards

Contour interval 25 feet

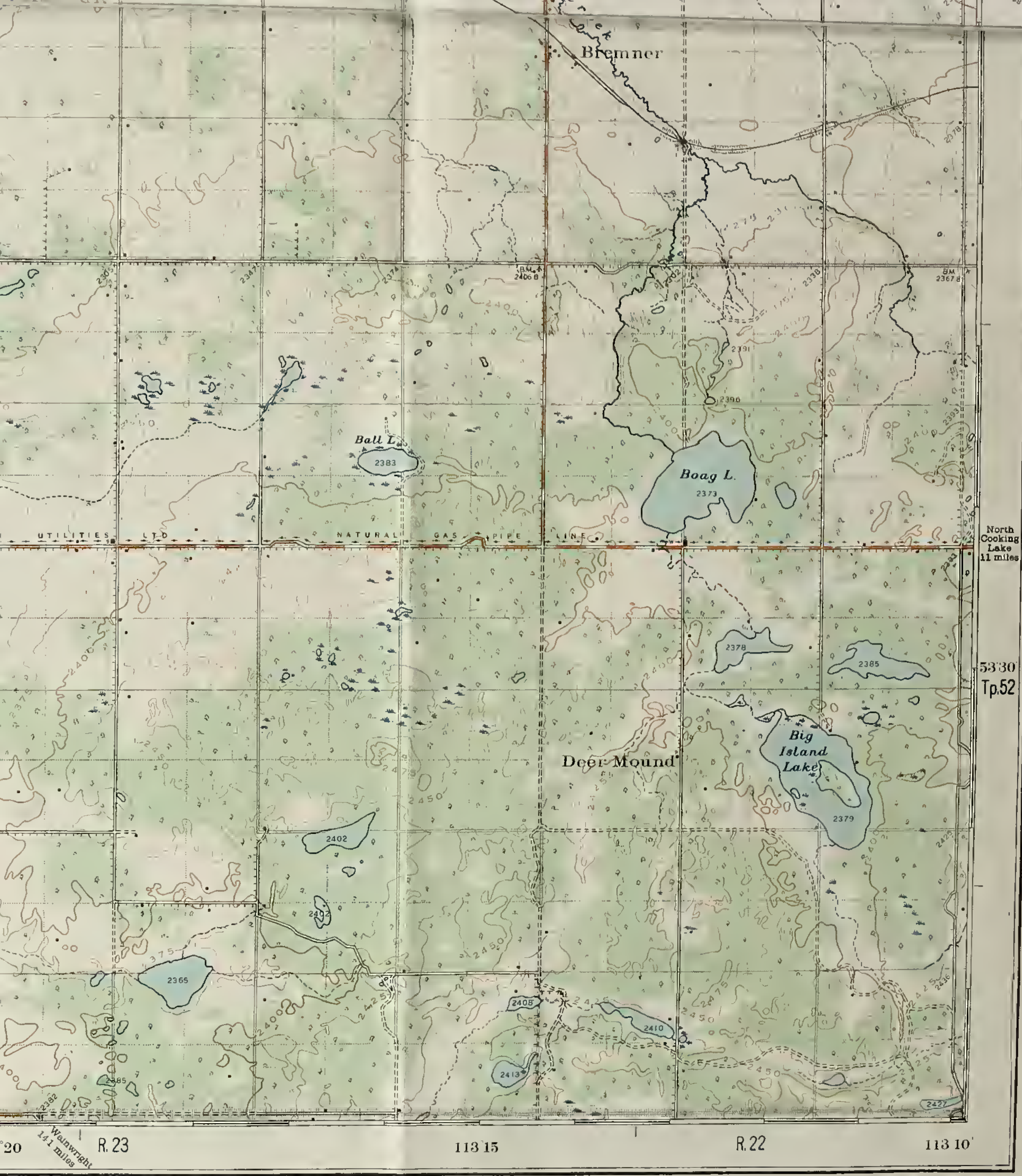
Datum is mean sea level.

Price 25 cents.
In folder form 50 cents.

Figures refer to localities mentioned in the text.
Location of poorly exposed outcrop....X

Reference

Culvert
Fall or Rapid
Culvert, Fall, Rapid
Non-perennial stream
Glacier
Contours and Cliffs
Depression contour
Elevator
Building
School
Post office
Telegraph office
Church, With spire or tower
" Without " "
(Centre of cross is centre of spire)
Hotel
Height in feet
Depth in feet
Road allowance
Heavy woods
Light woods
Quarry
Gravel or Sand pit
Blacksmith shop or garage
Gasoline station
Garage and gasoline station
Mines
Cemetery
Barn (isolated)
Bench marks



Compiled from surveys by the Topographical Survey of Canada, and from aerial photographs supplied by the Royal Canadian Air Force.

Reference

Culvert, Fall, Rapid	Culvert · Fall or Rapid · Fall · Rapid · Sand		
Non-perennial stream		Heavy woods	
Glacier		Light woods	
Contours and Cliffs.		Quarry	
Depression contour		Gravel or Sand pit	
Elevator	▲	Blacksmith shop or garage	F.
Building	■	Gasoline station	G.
School	S■	Garage and gasoline station	GG.
Post office	P.	Mines	⚒
Telegraph office	T.	Cemetery.	
Church, With spire or tower	♁	Mill, Saw mill	SM
" Without " "	+	" Grist or flour mill	GM
(Centre of cross is centre of spire)		" Other mill or factory	▲
Hotel	H.	Barn (isolated)	▭
Height in feet	1342	Triangulation station	△
Depth in feet	10	Bench marks	BM 1451 +
Road allowance		Bench marks on TSC monuments	BM 264

s

Yards

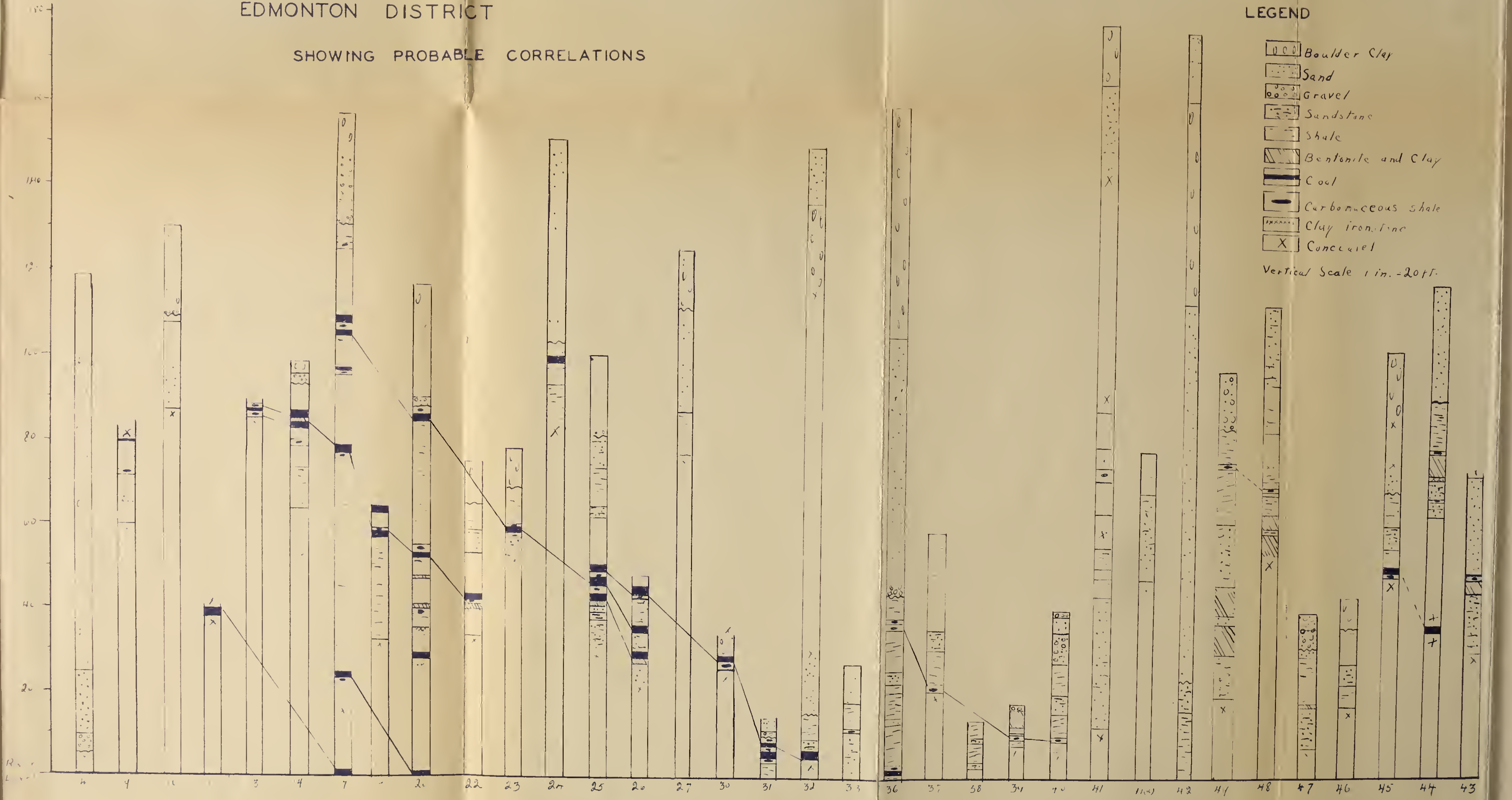
DIAGRAM OF TOWNSHIP

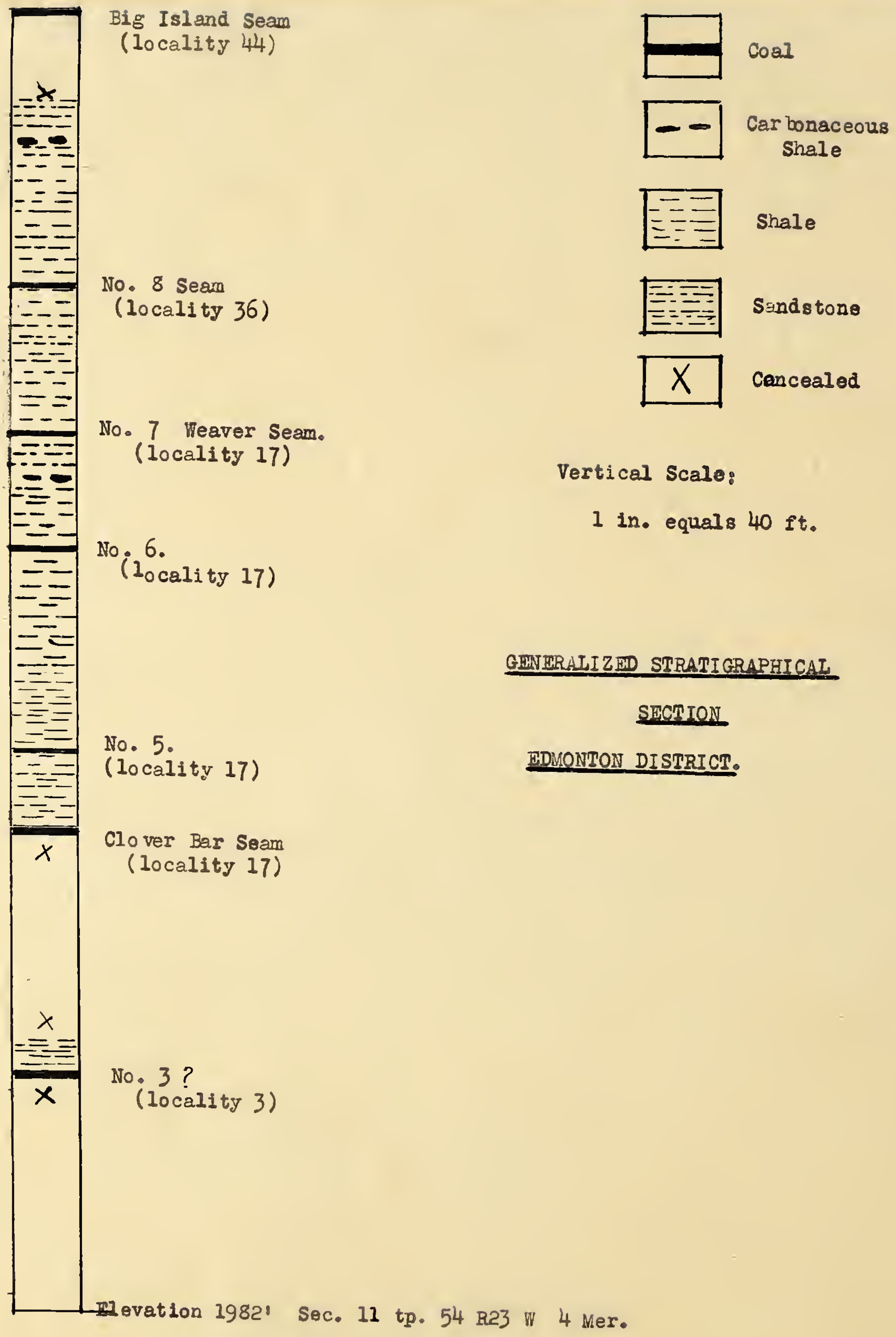
31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1

STRATIGRAPHICAL SECTIONS,

EDMONTON DISTRICT

SHOWING PROBABLE CORRELATIONS





Vertical Scale:

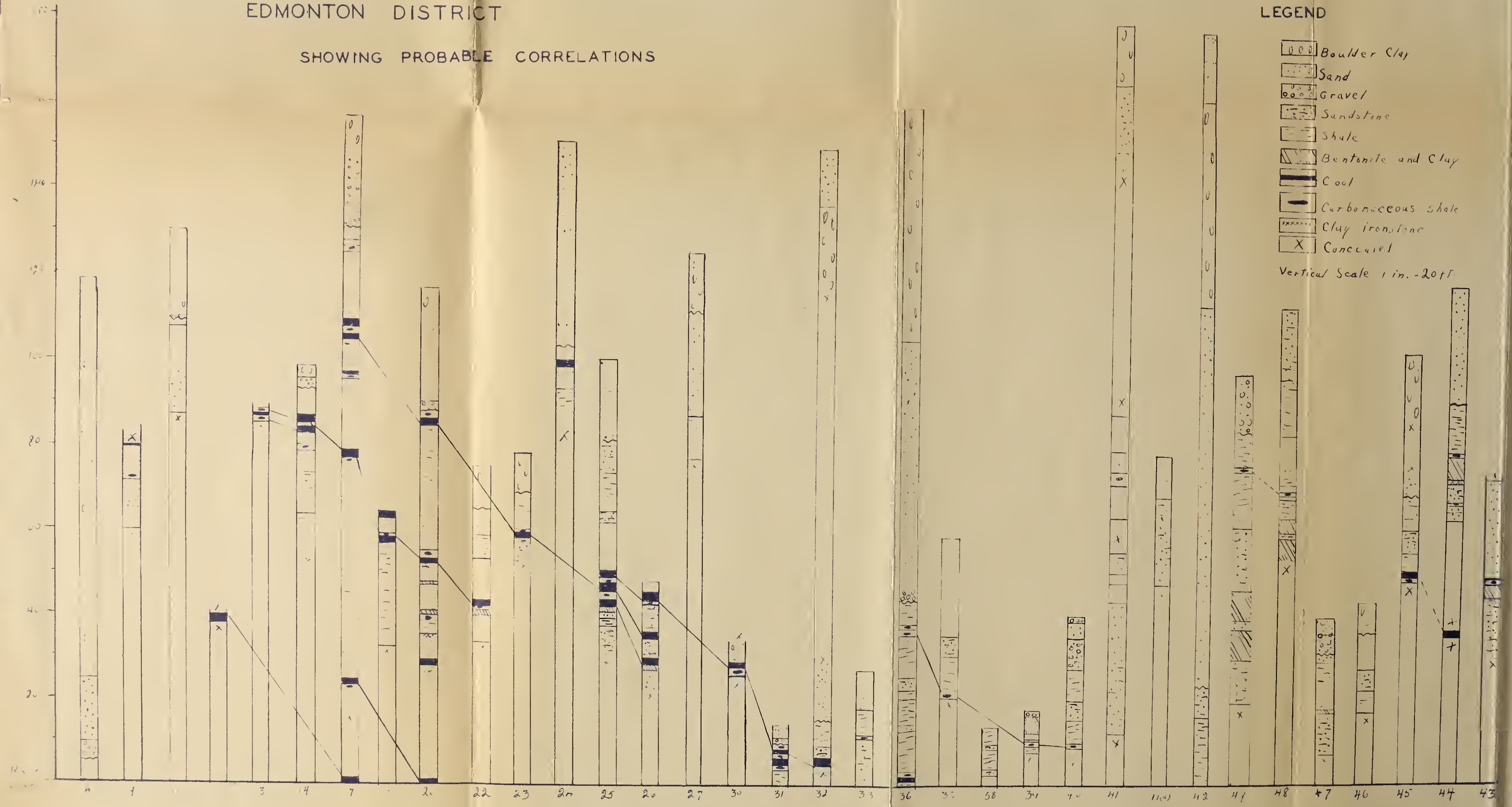
1 in. equals 40 ft.

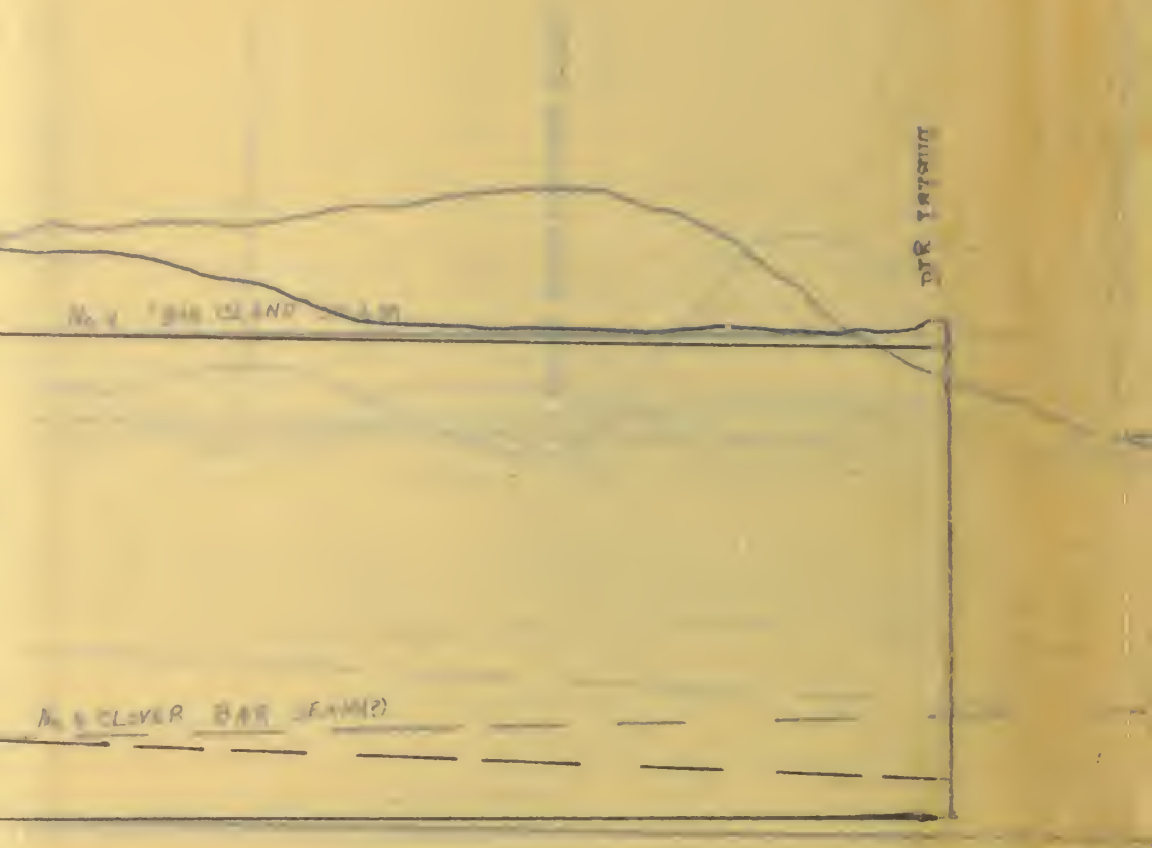
GENERALIZED STRATIGRAPHICAL SECTION

EDMONTON DISTRICT.

STRATIGRAPHICAL SECTIONS, EDMONTON DISTRICT

SHOWING PROBABLE CORRELATIONS




No. 4 'BIG ISLAND' SEAM
No. 5 CLOVER BAR SEAM(?)

B29742